

"I reflect on my childhood experience when I would visit a stream next to our home to fetch water for my mother. I would drink water straight from the stream. Playing among the arrowroot leaves I tried in vain to pick up the strands of frogs' eggs, believing they were beads. But every time I put my little fingers under them they would break. Later, I saw thousands of tadpoles: black, energetic and wriggling through the clear water against the background of the brown earth. This is the world I inherited from my parents. Today, over 50 years later, the stream has dried up, women walk long distances for water, which is not always clean, and children will never know what they have lost. The challenge is to restore the home of the tadpoles and give back to our children a world of beauty and wonder."

**Excerpt from Nobel Peace Prize
Acceptance Speech By Wangari Maathai**
10 December 2004

Africa: Atlas of Our Changing Environment is the first publication to use satellite photos to depict environmental change in each and every African country during the last thirty years. Through a rich array of satellite images, graphs, maps, and photographs, this Atlas presents a powerful testament to the adverse changes taking place on the African landscape as a result of intensified natural and human impacts. The remarkable developments in earth observation technology and its application during the last three decades have provided important tools for environmental monitoring. Earth-observing sensor systems on aircraft and spacecraft provide data streams for analysing environmental issues at varying spatial and temporal scales. The power of earth observations technologies to produce thousands of current and historical satellite images has illuminated the stories of environmental change, and has made this publication possible.

Africa: An Introduction to the Continent

There are 53 countries and one "non-self governing territory" (Western Sahara) in Africa. Ecologically, Africa is home to eight major biomes—large and distinct biotic communities with characteristic assemblages of flora and fauna. Chapter One of the Atlas vividly illustrates Africa's geographical attributes, presenting a physical setting in which readers may visualize the changes human actions are etching on the landscape. Maps, images and informative text reveal that Africa is endowed with rich natural resources that provide the basis for its peoples' livelihoods. Among the varied environmental features readers can see are rain forests, wetlands, mangroves, coral reefs, and coastal deltas. These ecosystems provide a rich and diverse array of potential sources of food and materials. In addition, Africa holds approximately 30 per cent of the earth's minerals including 40 per cent of the gold, 60 per cent of the cobalt and 90 per cent of its platinum. In recent years, oil production has been the main contributor towards Africa's economic growth. There are also grazing and agricultural lands that can support farming economies, as evidenced by the 56.6 per cent of Africa's labour force engaged in agriculture.

On the other hand, in many areas the environments from which most people in Africa must eke a living are harsh and the climate challenging. Africa is the world's hottest continent with deserts and drylands covering some 60 per cent of the entire land surface. Only ten per cent of farm soils are prime agricultural land, and more than one-quarter per cent of the land has moderate to low potential for sustainable agriculture. Rainfall variability is high, ranging from near 0 mm/year in parts of the Sahara to 9 500 mm/year near Mount Cameroon. Droughts and famine are ever present, and tens of millions of Africans have suffered the consequences every season. Droughts not only

directly cause food insecurity, triggering migration in some cases, but also negatively impact economic performance.

Water

Africa's water resources are continuously affected by persistent droughts and changes in land use. At the same time, a growing population is increasing the demand on already limited water supplies, particularly in areas which suffer from water shortages. Currently, it is estimated that over 300 million people in Africa face water scarcity conditions. About 75 per cent of the African population relies on groundwater as the major source of drinking water, particularly in northern and southern Africa. However, groundwater represents only about 15 per cent of the continent's total renewable water resources.

Land

Land in Africa is becoming increasingly degraded. Erosion and/or chemical and physical damage has degraded about 65 per cent of agricultural lands. This has forced farmers in many places to either cultivate marginal and unproductive soils, further degrading the land, or to migrate to cities and slums. Some areas in Africa are said to be losing over 50 metric tonnes of soil per hectare per year. Thirty-one per cent of the region's pasture lands and 19 per cent of its forests and woodlands are also classified as degraded. Forests account for over 20 per cent of Africa's 30 million km² of land area, but are being destroyed and degraded by logging and conversion to plantations, agriculture, roads, and settlements. As a region, Africa is losing more than four million hectares of forest every year—twice the world's average deforestation rate.

Biodiversity

Africa's rich biological diversity—one of the region's most stunning attributes—is in jeopardy due to a confluence of habitat destruction, poaching, and increasing populations. Africa contains over 3 000 protected areas including 198 Marine Protected Areas, 50 Biosphere Reserves, and 80 Wetlands of International Importance. Eight of the world's 34 international biodiversity hotspots are in Africa. Despite their recognized status,

these areas remain under threat by civil unrest and encroachment, as well as the introduction of alien species. Resolution of such predicaments has been undermined by administrative problems including lack of funding and inadequate staffing or training.

Changing Conditions

The Atlas paints a vivid picture of the rapid, and in some cases dramatic, transformations taking place on the lands and waters that sustain Africa's people. These include land degradation and desertification, water stress, declining biodiversity, deforestation, increasing dust storms, rising pollution and rapid urbanisation.

Moreover, climate change is likely to intensify these conditions and alter the environment even further. Although Africa emits only four per cent of total global carbon dioxide emissions, its inhabitants are projected to suffer disproportionately from the consequences of global climate change. Given its economic constraints, Africa's capacity to adapt to climate change is relatively low rendering the region exceptionally vulnerable to potential impacts. In many areas, even small changes in precipitation and water availability could have a devastating effect on agricultural output and therefore on food security. As climate change intensifies and its impacts deepen, adaptation will become increasingly difficult. Correspondingly, achieving targets set by the United Nations Millennium Development Goals (MDGs) will become more challenging.

Transboundary Environmental Issues

Chapter Two of the Atlas presents examples of transboundary environmental issues related to shared lands and waters, migrating animals and people, and pollutants that drift over borders of neighbouring countries. It highlights both emerging challenges and success stories in addressing these issues.

Africa has a number of large transboundary ecosystems—areas of land or sea that straddle one or more political boundaries. Some of these are officially protected areas which are extremely important for safeguarding Africa's remarkable animal populations and their habitats, truly one of the wonders of the



world. The importance of transboundary protected areas is especially obvious for migratory species, for example the Great Limpopo Transfrontier Park which connects South Africa's Kruger National Park, Mozambique's Limpopo National Park and Zimbabwe's Gonarezhou National Park; and the Ai-Ais/Richtersveld Transfrontier Park along the coast of South Africa and Namibia. Africa also has 59 international transboundary river basins, which cover about 64 per cent of the region's land area, contain 93 per cent of its total surface water, and are home to 77 per cent of the population. Multinational approaches are essential to conserving these shared areas, underscoring the need for cooperative management strategies among bordering countries.

Another transboundary issue of particular significance is the movement of air pollutants. Africa experiences the most extensive biomass burning in the world. Gaseous molecules emitted as a by-product of biomass burning can travel across national boundaries far from their original source. Fires contribute as much as 35 per cent to ground level ozone formation in Africa, bringing negative health consequences such as respiratory illnesses. The deserts contribute to dust storms that can drift over large areas.

Finally, political and economic difficulties give rise to refugee migrations, causing further pressure on the environment. Impacts resulting from masses of moving people affected by wars, conflicts, food and water shortages, and economic strife in one country may all extend into neighbouring countries. The Atlas displays a map of major refugee settlements scattered across the region, and images of their effects upon an already-stressed environment.

Tracking Progress Towards Environmental Sustainability

Chapter Three is the star attraction of this Atlas. It contains brief profiles of every African country, their important environmental issues, and a description of how each is faring in terms of progress towards the targets under the UN's Millennium Development Goal 7: ensure environmental sustainability. "Before and after" satellite images from every country highlight specific places where change is particularly evident.

This chapter also provides measures of progress towards the Millennium Development Goals' (MDG) environmental targets. The Atlas depicts whether or not each country has increased the percentage of its land area covered by forest, increased the land area covered by designated protected areas, decreased carbon emissions, improved access to clean water and sanitation, and reduced the slum population as a percent of urban population.

Between 1990 and 2004, a large number of countries witnessed real improvements in their efforts towards achieving the MDG targets that measure environmental progress. In many other cases, the improvements have been incremental, but promising (Figure 1). Most countries focused on improving those elements of the environment with direct relevance to human health (e.g.,

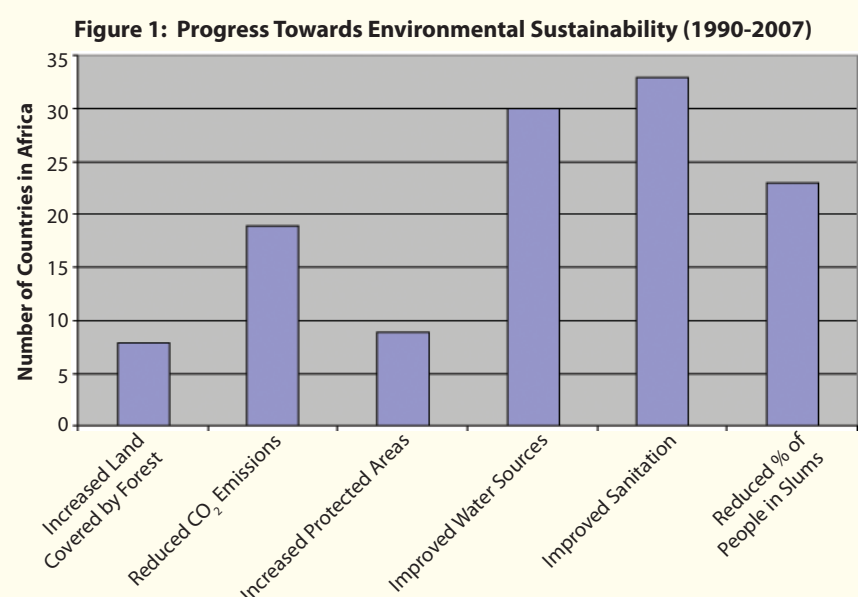
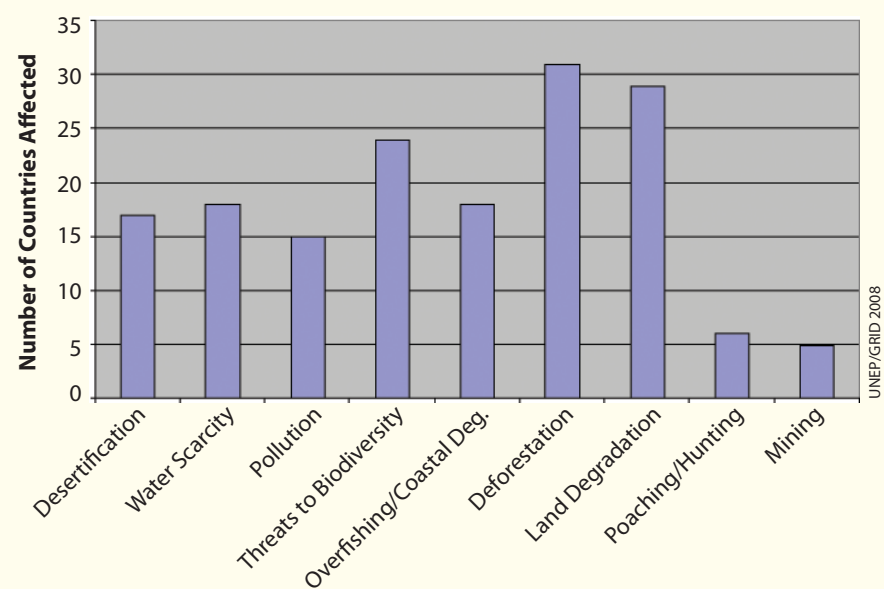


Figure 2: Examples of Important Environmental Issues in Africa



sanitation and water). Over 30 countries improved access to safe water and sanitation, and 23 countries reduced the percentage of people living in slums. A few countries have expanded protected areas. The most evident failure in progress towards the MDGs is in the loss of forest cover.

A comprehensive review was conducted using public information and peer-reviewed reports to identify the salient environmental issues each country faces, producing a unique environmental portrait of every African nation (see Table 1, page xiv-xv). The review indicates that deforestation is a main concern in 35 countries, land degradation is a key issue in 32 countries, and threats to biodiversity is a major issue in 34 countries. Overfishing and coastal degradation affect some 23 countries (Figure 2). Desertification, water scarcity, and air and water pollution are also critical issues. Many of the countries' separate issues of concern are interrelated, e.g., desertification and land degradation; and deforestation and threats to biodiversity. Although 'climate change' is not listed as an important issue, it is a possible driving force behind the problems noted.

Africa Then and Now: Images of a Changing Environment

The display of satellite images in Chapter Three provides scientific evidence of some of the scars that human activity and natural processes have left on the African landscape. These include but are not limited to: gouges made by mining operations; pock marks from bore holes; bald patches where forests once stood; and lakes that have completely disappeared. There are also images that reveal more diffuse, but nonetheless troublesome, change such as the swell of grey-coloured cities over a once-green countryside; threats to biodiversity by conversion of nature habitats; the tracks of road networks through forests; the erosion of deltas; and shrinking mountain glaciers.

Despite the numerous challenges, people across Africa are taking significant steps towards protecting and improving their environment. A number of images show the positive results of some of the many efforts undertaken to not only stem environmental destruction, but to reverse it. Success stories include land revitalisation evident by the growth of tree clusters in certain images of Niger, and in one instance, the expansion of wetlands resulting from a restoration project to control flooding in Mauritania.

In addition to well-publicised changes, such as Mount Kilimanjaro's melting glaciers, the shrinking of Lake Chad, and falling water levels in Lake Victoria, photographic evidence of a large number of new environmental hotspots is presented here for the first time. The following ten sites are examples selected from 104 such sites in this Atlas:



Ingenuity: a portable telephone, Uganda

©Paul Myhill

- The pressures of a dramatically growing population are illustrated in changing land use surrounding “W” National Park since the early 1970s. In contrast, the land cover within this protected savannah woodland in southeastern Burkina Faso remains relatively unchanged. The country’s most pristine protected area is an important elephant habitat.
- The widening of corridors of deforestation surrounding local roads in the northern area of the Democratic Republic of the Congo since 1975 is depicted with two striking images. New roads for commercial logging and a proposed road improvement project threaten to bring even greater traffic to this biologically diverse rain forest.
- The impact of a population explosion on farmland and forest is clearly seen in contrasting images of the Maradi District in Niger. A large area of savannah woodland was converted to agriculture between 1976 and 2007. In addition, the lack of fallow land among farms in 2007 reveals the intensity of farming in this district.
- In the past half-century or so, the population of Senegal has soared, with much of the growth occurring in its urban areas. The dramatic expansion in the capital, Dakar, between 1942 and 2007 is shown via aerial photography from the 1940’s and a recent high-resolution satellite image. Originally occupying a small centre of urban development at the tip of the Cap Vert Peninsula, the Dakar metropolitan area has grown to a population of nearly 2.5 million people spread over the entire area.
- A large portion of southwestern Madagascar’s South Malagasy spiny forest has evidently disappeared between 1973 and 2003. Farming, and to a lesser extent, fuelwood gathering, have taken a large bite out of this biodiversity hotspot which is home to several endemic species.
- Protection from grazing in the Sidi Toui National Park in southeastern Tunisia produced a dramatic rebound in the natural ecosystem. Satellite images from 1987 and 2006 show the revival of grasses and scrub inside the park’s boundaries, which appear like puzzle pieces dropped onto the otherwise degraded landscape. The Scimitar-horned oryx (*Oryx dammah*), now near extinction, was reintroduced to the park in 1999.
- Greenhouses can be seen replacing desert-fighting trees in images that show the striking transformation of the Souss-Massa Valley in Morocco since 1988. The greenhouses use scarce water resources more efficiently than unprotected agriculture. However, the loss of many of the Argan trees in the valley due to agricultural practices and a depleted water table, has removed one of nature’s ways of combating desertification.
- A new management plan for the Itezhi-tezhi Dam in Zambia has helped to restore the natural seasonal flooding of the Kafue Flats. A satellite image from early 2007 captures the height of the first flood season where water was released from the dam to assist natural flooding.
- The remarkable appearance of a chain of lakes in the deserts of Egypt is captured in a series of satellite images beginning in the late 1980s. A massive volume of water was released through Lake Nasser’s spillway to prevent flooding damage along the Nile Valley. The New Valley Project will

continue sending Nile water into the desert to support an enormous irrigation scheme.

- A large area of natural “fynbos” vegetation on the northern edge of Cape Town in 1978 is shown being replaced with large farms and suburban development, as Cape Town’s growing population pushes outward. The “fynbos” vegetation accounts for 80 per cent of the plant varieties in the Cape Floristic Region, an area with over 6 000 plant species found nowhere else in the world.

Looking Forward

Those who read this Atlas and reflect upon its images will have gained a deeper understanding of the impacts upon Africa’s land, plants, animals, air and waters. The pace and scale of change are hard to ignore. The Atlas also contains a few signs of hope in our ability to protect against, and even reverse environmental degradation. As shown throughout, there are inspiring photos of

places where people have taken action—where there are more trees than 30 years ago, where wetlands have sprung back, and where land degradation has been stymied. These are beacons we need to follow to ensure the survival of our environment and of the world’s peoples.

Observations and assessments of environmental change, as illustrated by this Atlas, not only help gauge how close or far we are from the targets of the United Nations Millennium Development Goals, they also contribute to the knowledge and understanding that are essential for adaptation and remediation. But significant differences exist between developed and developing countries and these realities cannot be ignored. “The developed countries want us to keep the forests, since the air we breathe is for all of us, rich countries and poor countries,” said Ogar Assam Effa, 54, a tree plantation director and member of the state conservation board of Nigeria’s southeastern Cross Rivers State. “But we breathe the air, and our bellies are empty. Can

Important Environmental Issues in African Countries

Algeria	<ul style="list-style-type: none"> • Desertification • Water Scarcity • Pollution 	Djibouti	<ul style="list-style-type: none"> • Water Scarcity • Land Availability and Desertification • Marine Resources and Pollution
Angola	<ul style="list-style-type: none"> • Threats to Biodiversity • Access to Potable Water • Overfishing and Coastal Degradation 	Egypt	<ul style="list-style-type: none"> • Urbanisation and Pollution • Soil Erosion and Land Degradation • Threats to Biodiversity
Benin	<ul style="list-style-type: none"> • Deforestation • Desertification • Threats to Biodiversity 	Equatorial Guinea	<ul style="list-style-type: none"> • Oil Production and Coastal Degradation • Deforestation • Bushmeat and Hunting on Bioko Island
Botswana	<ul style="list-style-type: none"> • Overgrazing and Desertification • Water Scarcity and Urbanisation • Wildlife of the Okavango Delta 	Eritrea	<ul style="list-style-type: none"> • Water Stress • Land Availability and Degradation • Deforestation and Threats to Biodiversity
Burkina Faso	<ul style="list-style-type: none"> • Water Scarcity • Land Degradation and Desertification • Deforestation 	Ethiopia	<ul style="list-style-type: none"> • Water Availability and Access to a Safe Source • Livestock, Soil Erosion and Land Degradation • Threats to Biodiversity and Endemism
Burundi	<ul style="list-style-type: none"> • Land Availability and Degradation • Deforestation • Lake Tanganyika Ecosystems and Fisheries 	Gabon	<ul style="list-style-type: none"> • Threats to Biodiversity • Coastal Degradation and Industrial Pollution • Lack of Sanitation and the Urban Environment
Cameroon	<ul style="list-style-type: none"> • Land Degradation and Deforestation • Over-harvesting of Biological Resources • Degradation of Coastal and Marine Ecosystems 	Gambia	<ul style="list-style-type: none"> • Drought and Agricultural Productivity • Threats to Forest and Wetland Ecosystems • Overfishing and Coastal Erosion
Cape Verde	<ul style="list-style-type: none"> • Soil Erosion and Land Degradation • Threats to Biodiversity 	Ghana	<ul style="list-style-type: none"> • Deforestation • Land Degradation and Coastal Erosion • Overfishing and Reduced Water Volume in Lake Volta
Central African Republic	<ul style="list-style-type: none"> • Subsistence and Commercial Poaching • Deforestation and Land Degradation • Diamond Mining and Pollution 	Guinea	<ul style="list-style-type: none"> • Deforestation and Refugees • Overfishing and Destruction of Mangrove Forests • Land Degradation
Chad	<ul style="list-style-type: none"> • Drought • Desertification and Land Degradation • Access to Water and Sanitation 	Guinea-Bissau	<ul style="list-style-type: none"> • Deforestation • Cashew Farming and Soil Erosion • Threats to the Bijagos Biosphere Reserve
Comoros	<ul style="list-style-type: none"> • Deforestation and Soil Erosion • Threats to Coastal Ecosystems 	Kenya	<ul style="list-style-type: none"> • Water Scarcity and Pollution • Desertification and Deforestation • Degradation of Freshwater Ecosystems
Congo	<ul style="list-style-type: none"> • Wildlife Poaching • Threats to Coastal Ecosystems and Inland Wetlands • Deforestation 	Lesotho	<ul style="list-style-type: none"> • Degradation of Rangelands • Threats to Biodiversity in the Lesotho Highlands • Water Resource Management and Pollution
Congo, Democratic Republic of the	<ul style="list-style-type: none"> • Wildlife Poaching • Deforestation • Mining and Ecosystem Degradation 	Liberia	<ul style="list-style-type: none"> • Deforestation and Rubber Plantations • Threats to Biodiversity • Water Pollution
Côte d’Ivoire	<ul style="list-style-type: none"> • Deforestation • Threats to Biodiversity • Threats to Coastal Ecosystems 	Libyan Arab Jamahiriya	<ul style="list-style-type: none"> • Water Scarcity • Land Conversion and Desertification • Oil Production and Pollution

air give you protein? Can air give you carbohydrates?” he asked. “It would be easy to convince people to stop clearing the forest if there was an alternative” (Quoted from the *chicagotribune.com*—Rain Forests Fall at ‘Alarming’ Rate—By Edward Harris, Associated Press Writer February 3, 2008).

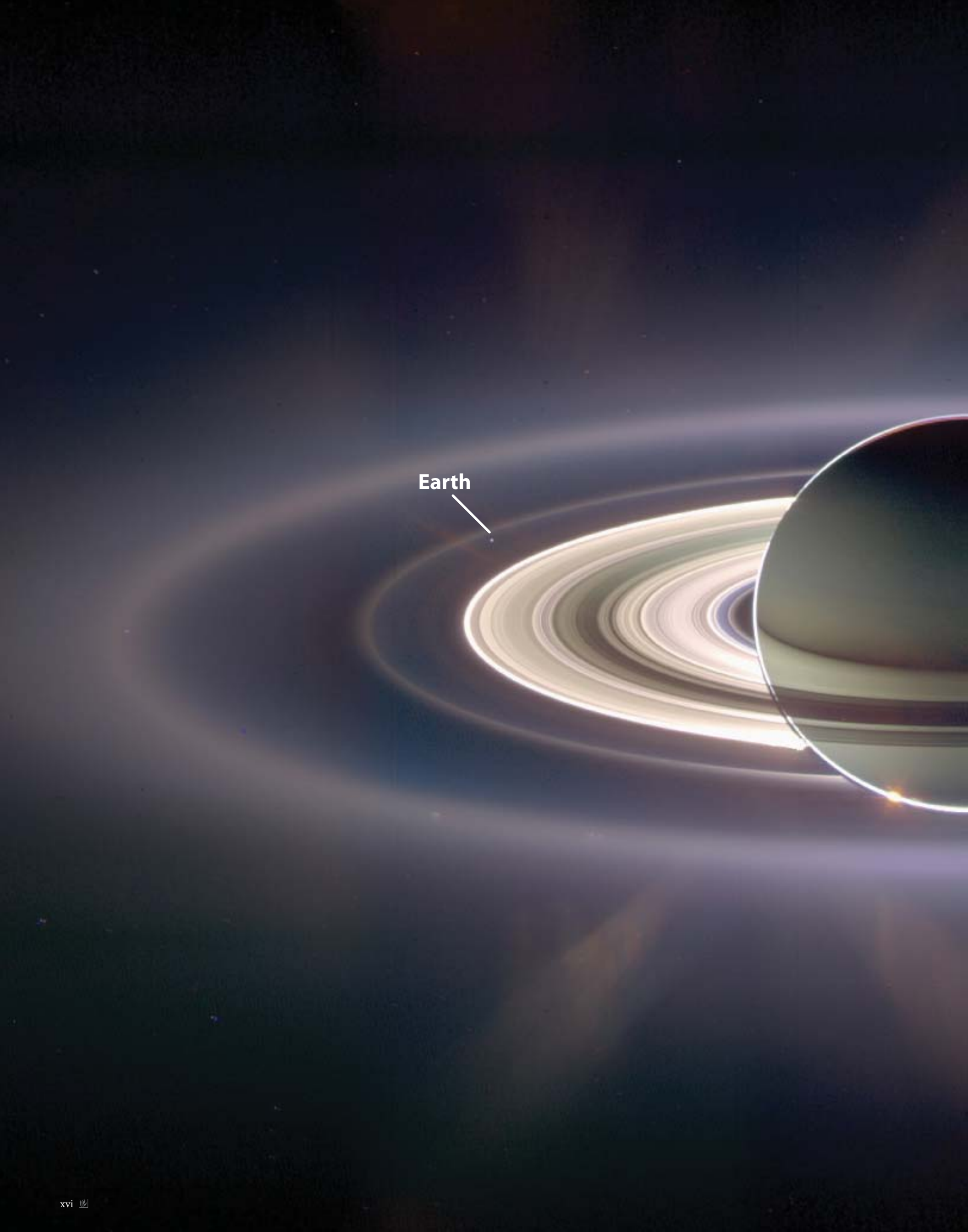
As for the people whose footprints we see so strikingly stamped on the pages, to some degree their ability to choose plays a role in the choices ultimately made. As Nelson Mandela, Nobel Laureate and Former President of the Republic of South Africa, tersely put it, “... For me, survival is the ability to cope with difficulties, with circumstances, and to overcome them.”

Alleviation of poverty is a key step towards establishing an environment in which people are empowered to make sustainable choices. The economy of Africa can be expanded beyond its agricultural base to increased investment in the services and manufacturing sectors. Development for both local consumption

and exports, balanced with environmental preservation, can bring Africa to a position where its wealth of natural resources is more accurately reflected in the economic status of its peoples. Coupled with education and training, and empowerment of women, a broadened economy in Africa would enhance local employment prospects as well as economic opportunities to trade in world markets.

Many factors, such as governmental policies, cultural and social milieu, play a role in whether we will achieve global environmental sustainability. But as is the case in environmental systems, all the pieces are interconnected. Once people are secure enough to choose, one can, if wise, opt for the land and resource-use alternatives that are sustainable and regenerative. In the absence of such opportunities, it is likely that people will continue to make expedient choices for their survival, which, voluntarily or involuntarily, can result in environmental degradation.

Madagascar	<ul style="list-style-type: none"> • Soil Erosion • Endemism and Threats to Biodiversity • Deforestation 	Sierra Leone	<ul style="list-style-type: none"> • Deforestation • Land Degradation • Overfishing
Malawi	<ul style="list-style-type: none"> • Land Scarcity and Soil Erosion • Deforestation for Fuelwood • Water Pollution and Aquatic Biodiversity 	Somalia	<ul style="list-style-type: none"> • Threats to Biodiversity • Desertification, Overgrazing and Deforestation • Water Scarcity and Drought
Mali	<ul style="list-style-type: none"> • Desertification and Drought • Water Availability and Pollution • Threats to Biodiversity 	South Africa	<ul style="list-style-type: none"> • Water Availability and Quality • Land Degradation • Threats to Biodiversity
Mauritania	<ul style="list-style-type: none"> • Desertification and Deforestation • Iron Mining • Fisheries and Coastal Ecosystems 	Sudan	<ul style="list-style-type: none"> • Soil Erosion and Land Degradation • Poaching and the Ivory Trade • Forests and Fisheries
Mauritius	<ul style="list-style-type: none"> • Coastal Water Pollution • Threats to Biodiversity 	Swaziland	<ul style="list-style-type: none"> • Population Encroachment and Land Degradation • Irrigation and Soil Degradation • Threats to Biodiversity and Invasive Alien Species
Morocco	<ul style="list-style-type: none"> • Drought and Desertification • Water Scarcity • Pollution 	United Republic of Tanzania	<ul style="list-style-type: none"> • Water Pollution and Aquatic Ecosystems • Land Degradation and Deforestation • Threats to Biodiversity and Ecosystems
Mozambique	<ul style="list-style-type: none"> • Water Access and Natural Disasters • Land Use • Protecting Wildlife and Forests 	Togo	<ul style="list-style-type: none"> • Land Degradation and Deforestation • Threats to Aquatic Ecosystems • Threats to Biodiversity
Namibia	<ul style="list-style-type: none"> • Land Degradation and Desertification • Aridity and Water Scarcity • Threats to Biodiversity 	Tunisia	<ul style="list-style-type: none"> • Land Degradation and Desertification • Water Scarcity • Air and Water Pollution
Niger	<ul style="list-style-type: none"> • Desertification and Deforestation • Threats to Wildlife • Environmental Consequences of Mining 	Uganda	<ul style="list-style-type: none"> • Land Degradation and Deforestation • Habitat Degradation and Threats to Biodiversity • Water Availability and Pollution
Nigeria	<ul style="list-style-type: none"> • Desertification • Deforestation and Threats to Biodiversity • Oil Pollution 	Western Sahara (non-self-governing territory)	<ul style="list-style-type: none"> • Land Use and Food Production • Water Resources • Marine Fisheries
Rwanda	<ul style="list-style-type: none"> • Population Pressure on Land • Soil Erosion and Sedimentation • Deforestation and Threats to Biodiversity 	Zambia	<ul style="list-style-type: none"> • Copper Mining and Water and Air Pollution • Deforestation and Wildlife Depletion • Urbanisation
São Tomé and Príncipe	<ul style="list-style-type: none"> • Degradation of Forest Ecosystems • Threats to Biodiversity 	Zimbabwe	<ul style="list-style-type: none"> • Land Degradation and Deforestation • Water Access and Drought • Wildlife Poaching and the Black Rhinoceros
Senegal	<ul style="list-style-type: none"> • Urban Pollution • Deforestation • Coastal Wetlands and Fisheries Over-exploitation 		
Seychelles	<ul style="list-style-type: none"> • Severe Weather and Coastal Erosion • Loss of Mangrove Forests and Protection of Coral Reefs 		



Earth



A View of **Earth** from **Space**

Seen through the rings of Saturn, Earth appears as little more than a shining dot in this satellite composite image taken by the Cassini spacecraft in 2006. At this distance, the nature of Earth is obscure. A closer view, however, reveals that our planet is unique in the solar system, home to seven major continents scattered across a network

of oceans. Each of these continents, too, is unique. The second largest—Africa—spans the equator and stretches from northern temperate to southern temperate zones. Understanding Africa requires an understanding of its vastly diverse ecosystems, as well as the many challenges its people face both today and tomorrow.



A new bride, Ethiopia